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HAYES,
SOLOWAY,
HENNESSEY,
GROSSMAN
& HAGE, P.C.

175 CANAL STREET
MANCHESTER, NH
03101-2335 U.S.A.
TEL 603-668-1400
FAX 603-668-8567
FAX 603-668-0104

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Dear Sir:

Transmitted herewith for filing is the patent application of:

INVENTOR: Satoshi KATOH

FOR: IMAGE TAKING APPARATUS

Enclosed are the following:

- Specification: 37 pages; Claims: 6 pages; Abstract: 1 page
- Declaration and Power of Attorney
- Sheet(s) of drawings 8 pages
- An assignment of the invention to: NEC Corporation
- A certified copy of Japanese application No. 11-319606 filed November 10, 1999.
- Prior Art Disclosure Statement

Priority is hereby claimed under 35 USC 119 by way of Japanese application No. 11-319606
filed November 10, 1999.

The filing fee has been calculated as shown below:

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Norman P. Soloway
 Attorney for Applicant
 Reg. No. 24,315

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IMAGE TAKING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to an image taking apparatus that displays an image taken by a solid state image taking device on a display, in particular, in which the power consumption of the total system of the image taking apparatus is reduced at the time when a monitoring image is displayed on the display.

Description of the Related Art

Among image taking apparatuses, an electronic still camera, which displays an image taken by a solid state image taking device such as a charge coupled device (CCD) on a displaying apparatus such as a liquid crystal display (LCD) as a monitoring image, and also in which the image is recorded in a recording medium such as a floppy disk or a memory card, has been rapidly and widely used in the market.

At the solid state image taking device used in the electronic still camera, a CCD having more than 2 million pixels has been now used mainly instead of the CCD having about 1.3 million pixels, and an electronic still camera provided a CCD having a large number of pixels has been rapidly developed.

The reasons why the electronic still camera provided the CCD having a large number of pixels has been widely developed are explained below. First, the cost of the solid state image taking device has been decreased. Secondly, the performance of central processing unit (CPU) has been improved rapidly as represented in Pentium CPU, and the large number of data has been processed easily at a consumer use personal computer (PC) by that the recording medium has become large capacity. And a high definition image being more than a video graphics array (VGA) class image, used mainly in a few years ago, has been required by users. In this, the Pentium is a registered trademark of Intel Corp.

In the near future, the electronic still camera will use a solid state image taking device having larger pixels, and will become a multi function, and will be used for various purposes. However, the power consumption of the total system of the electronic still camera will be increased because of the larger number of pixels and the multi function.

In case that the number of pixels is increased, the electrode capacity of the solid state image taking device is increased. And the driving frequency of the solid state image taking device may also increase in proportion to the increase of the number of pixels.

As a result, the power consumption of a driving circuit for driving the solid state image taking device is increased, and the operating frequency of the total system of the electronic still camera is also increased, therefore, the power consumption of the total system of the electronic still camera is increased.

Further, corresponding to the multi function of the electronic still camera, in addition to the displaying apparatus and the recording medium mentioned above, a TV set and/or a PC is connected to the total system of the electronic still camera. With this additional connection, the power consumption of the total system of the electronic still camera will be increased.

Consequently, the life of a battery being a power source is decreased, and the shooting time is forced to decrease and the number of recording images is forced to decrease. Therefore, even the multi function of the electronic still camera is achieved, the multi function can not be used sufficiently.

Therefore, at the development of the electronic still camera, in which the performance and the functions of the electronic still camera must be studied, it is also very important to reduce the power consumption of the total system of the electronic still camera. At the electronic still camera, the number of times displaying images such as

monitoring images on the LCD is large, and further, the power consumption of the LCD is large. Therefore, in order to reduce the power consumption of the total system, it is very effective that the power consumption of the total system is decreased at the time when the image
5 is displayed on the LCD.

In order to solve the problem mentioned above, various technologies, in which the power consumption of the total system is decreased at the time when the image is displayed on the LCD, have been disclosed. For example, these technologies are disclosed in Japanese
10 Patent Applications Laid-Open No. HEI 11-164178, HEI 11-136551, HEI 10-276356, and HEI 9-93470.

These conventional technologies, in which the power consumption of the total system of the electronic still camera at the time displaying the image on the LCD is reduced, are explained.

15 First, the electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 11-164178 is explained. Fig. 1 is a block diagram showing a structure of the conventional electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 11-164178.

20 As shown in Fig. 1, the conventional electronic still camera consists of an image taking circuit 501, a signal processor 502, a compression/expansion circuit 503, an image information memory 504, a CPU 505, a compression rate setting switch 506, an amount of light controlling circuit 507, a brightness adjusting volume 508, an LCD 25 monitor 509, and a back-light 510.

At this conventional electronic still camera, the compression rate of image data of an image to be taken at the image taking circuit 501 is set beforehand at the compression rate setting switch 506. After this setting, the image data are started to take at the image taking circuit 501.
30 In this, the compression rate of the image data corresponds to the image

quality of the image, the higher the compression rate is, the worse the image quality of the image is.

The image taking circuit 501 takes image data and outputs the image data to the signal processor 502. The signal processor 502
5 converts the image data outputted from the image taking circuit 501 to image data for displaying on the LCD monitor 509 and outputs the converted image data.

The compression/expansion circuit 503 compresses the image data outputted from the signal processor 502 by the compression rate set
10 at the compression rate setting switch 506. The image information memory 504 stores the image data compressed at the compression/expansion circuit 503.

The amount of light controlling circuit 507, in case that the image data stored in the image information memory 504 is reproduced
15 and displayed on the LCD monitor 509, controls the amount of light of the back-light 510 for the LCD monitor 509 based on the compression rate of the image data stored in the image information memory 504. The brightness adjusting volume 508 adjusts the amount of light controlling circuit 507 finely.

20 The CPU 505 controls the signal processor 502, the compression/expansion circuit 503, the amount of light controlling circuit 507, and the brightness adjusting volume 508.

At this conventional electronic still camera having the structure mentioned above, in case that the image data stored in the image information memory 504 is compressed by a compression rate that
25 is lower than a normal compression rate, the amount of light controlling circuit 507 controls so that the amount of light of the back-light 510 becomes lighter than normal light. And in case that the image data stored in the image information memory 504 is compressed by a
30 compression rate that is higher than the normal compression rate, the

amount of light controlling circuit 507 controls so that the amount of light of the back-light 510 becomes darker than the normal light.

That is, at this conventional electronic still camera, in case that an image data whose image quality is low is displayed on the LCD monitor 509, the amount of light of the back-light 510 is controlled to be darker than the normal light. With this, the power consumption of the total system is reduced.

Next, the electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 11-136551 is explained. Fig. 2 is a block diagram showing a structure of the conventional electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 11-136551.

As shown in Fig. 2, this conventional electronic still camera consists of a camera 601, an LCD 602, a back-light 603 for the LCD 602, a controller 604 for controlling the amount of light of the back-light 603, input switches 608, 609, and 610 for setting conditions at taking or reproducing images, a sensor 607 for sensing the inputted state of the input switches 608, 609, and 610, a timer 606 that starts counting from the time when any of the input switches 608, 609, and 610 is inputted base on the sensed result of the sensor 607, a memory 605 for memorizing the amount of light of the back-light 603, a setting display panel 611 for displaying the setting conditions at the taking or reproducing images base on the inputted state of the input switches 608, 609, and 610, and a power source 612. In this, the LCD 602 is disposed in the camera 601.

At this conventional electronic still camera having the structure mentioned above, in case that it is judged that a photographer is operating the input switches 608, 609, and 610 base on the counted number at the timer 606, the controller 604 judges that the photographer is not watching the LCD 602 attentively, and controls so that the amount of light of the back-light 603 for the LCD 602 becomes dark.

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That is, at this conventional electronic still camera, when the image is displayed on the LCD 602, in case that the photographer is setting the conditions at taking or reproducing images, the amount of the back-light 603 is controlled to become dark. With this, the power consumption of the total system is reduced.

Next, the electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 10-276356 is explained. Fig. 3 is a block diagram showing a structure of the conventional electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 10-276356.

As shown in Fig. 3, this conventional electronic still camera consists of an image taking section 702 which converts an optical image of a subject to be taken to image data and outputs the converted image data, a capture memory 703 which stores the image data outputted from the image taking section 702 temporarily, a displaying section 704 which provides a LCD 741 that displays the image data stored in the capture memory 703, and a controller 701 which controls the image data to be displayed on the LCD 741.

The image taking section 702 consists of a CCD 721 which converts an optical image of a subject to be taken to image data and outputs the converted image data to the capture memory 703, and a CCD controller 722 which drives the CCD 721.

The controller 701 consists of an exposure controller 711 which calculates an exposure based on the brightness of the image data stored in the capture memory 703 and sets a shutter speed to the CCD controller 722 in the image taking section 702 based on this calculated result, an LCD brightness controller 712 which sets the brightness of the LCD 741 based on the calculated result at the exposure controller 711, and an LCD display controller 713 which converts the image data stored in the capture memory 703 to image data to be displayed on the LCD 741 and

outputs the converted image data to the displaying section 704.

The displaying section 704 consists of the LCD 741, and an LCD controller 742 which controls the LCD 741 based on the brightness set at the LCD brightness controller 712 and the image data outputted 5 from the LCD display controller 713.

At this conventional electronic still camera having the structure mentioned above, the exposure is calculated at the exposure controller 711 based on the brightness of the image data stored in the capture memory 703, and the brightness of the LCD 741 is controlled by 10 the exposure calculated at the exposure controller 711.

That is, at this conventional electronic still camera, in case that it is judged that image data, whose surroundings of a subject to be taken are dark, are displayed on the LCD 741, the brightness of the LCD 741 is controlled to make low. With this, the power consumption of the total 15 system is reduced.

Next, a monitor controlling apparatus for an electronic still camera disclosed in the Japanese Patent Application Laid-Open No. HEI 9-93470 is explained. Fig. 4 is a block diagram showing a structure of this monitor controlling apparatus for the electronic still camera disclosed 20 in the Japanese Patent Application Laid-Open No. HEI 9-93470.

As shown in Fig. 4, this monitor controlling apparatus for the electronic still camera consists of an electronic still camera 801, a memory card 823, a hard disk 827, a computer 824, and a TV set 833.

The electronic still camera 801 consists of a system controller 25 810, an optical block 811, a CCD (solid state image taking device) 812, a CCD driver 813, clock generators 814 and 837, a correlated double sampling sample hold circuit 815 (hereinafter referred to as CDS), an A/D converter 816, a pulse gate circuit 817, a frequency divider 818, an image memory 819, a video digital signal processor 821 (hereinafter referred to 30 as DSP), an interface (I/F) circuit 822, a card connector 825, an external

connector 826, a D/A converter 831, a monitor driver 832, a video out connector 834, an LCD driver 835, an LCD 836, and an operating panel 838.

At this electronic still camera 801, operation is executed by either one of two modes, that is, a monitor through mode in which pixel signals obtained through the CCD 812 are displayed on the LCD 836 as a moving image, and a recording mode in which the pixel signals obtained through the CCD 812 are recorded in a recording medium such as the memory card 823 as a still image.

The system controller 810 is a micro computer and controls the total operation of the electronic still camera 801.

The optical block 811 is a lens to take an image, and at the CCD 812, photo diodes (not shown) are formed on its light receiving surface, and further color filters (not shown) are disposed on the photo diodes.

Light passed through the optical block 811 enters the light receiving surface of the CCD 812, and pixel signals corresponding to the subject to be taken are generated on the photo diodes formed on the light receiving surface of the CCD 812.

The CCD 812 outputs the pixel signals generated on the photo diodes to the CDS 815.

The CCD driver 813 drives the CCD 812 synchronized with a clock signal outputting from the clock generator 814 in a designated cycle. That is, the CCD 812 outputs the pixel signals to the CDS 815 synchronized with the clock signal outputted from the clock generator 814.

The pulse gate circuit 817 outputs a sample hold (S/H) pulse signal to the CDS 815 based on the pulse signal outputted from the clock generator 814. The CDS 815, based on the pulse signal outputted from the pulse gate circuit 817, executes signal processes such as a process to remove noise from the pixel signals outputted from the CCD 812, and

outputs the pixel signals, in which the signal process was executed, to the A/D converter 816.

The frequency divider 818, based on the pulse signal outputted from the clock generator 814, outputs an A/D clock signal to the A/D converter 816. The A/D converter 816, based on the A/D clock signal outputted from the frequency divider 818, applies A/D conversion to the pixel signals outputted from the CDS 815.

At this monitor controlling apparatus for the electronic still camera, the operation of the CDS 815, the A/D converter 816, the pulse gate circuit 817, and the frequency divider 818 is different between at the monitor through mode and the recording mode. That is, at the A/D converter 816, the cycle of the A/D conversion is different between at the monitor through mode and the recording mode.

Therefore, the A/D converter 816 applies the A/D conversion to the total pixel signals outputted from the CCD 812 at the recording mode, and applies the A/D conversion to about a half of the total pixel signals outputted from the CCD 812 at the monitor through mode.

The image memory 819 stores the pixel signals applied the A/D conversion at the A/D converter 816. The DSP 821 executes color processes such as complementary color/primary color conversion, a white balance process, a gamma correction to the pixel signals stored in the image memory 819 based on a DSP clock signal outputted from the frequency divider 818. And with these processes mentioned above, the DSP 821 generates primary color signals and outputs the generated primary color signals to the I/F circuit 822. The I/F circuit 822 converts the primary color signals outputted from the DSP 821 to a format with which the primary color signals are recorded in the memory card 823 or a format with which the primary color signals are recorded in the hard disk 827 connected to the computer 824.

The memory card 823 is detachable at the card connector 825.

And also the computer 824 is detachable at the external connector 826.

The D/A converter 831 converts the primary color signals outputted from the DSP 821 to analog signals. The monitor driver 832 converts the primary color signals converted to the analog signals at the 5 D/A converter 831 to, for example, signals of the NTSC system, and outputs this converted signals to the TV set 833 through the video out connector 834. The LCD diver 835, based on a clock signal outputted from the clock generator 837, applies a process to make the primary color signals outputted from the DSP 821 display on the LCD 836. The LCD 10 836 displays the pixel signals outputted from the CCD 812 at real time as the moving image at the monitor through mode.

In this, the LCD diver 835 operates based on a clock signal outputted from the clock generator 837 in a designated cycle.

At the operating panel 838, a change-over switch for selecting 15 either one of the monitor through mode and the recording mode is provided.

At this monitor controlling apparatus of the electronic still camera having the structure mentioned above, the cycle for executing the A/D conversion at the A/D converter 816 is made to be different between 20 the monitor through mode and the recording mode. And at the monitor through mode, the A/D converter 816 applies the A/D conversion to about only a half of the total pixel signals outputted from the CCD 812.

That is, at this monitor controlling apparatus of the electronic still camera, in case that the pixel signals are displayed on the LCD 836, 25 about the half of the total pixel signals are thinned out at the monitoring through mode, and about the half of the total pixel signals are displayed on the LCD 836. With this, the power consumption of the total system is reduced.

At the electronic still camera, a high definition image quality is 30 required as high as possible for an image recording on a recording

medium or an image processed at a personal computer. On the other hand, an image to be displayed on an LCD is not required to be a high definition image quality, generally, it is sufficient that the image has about 200000 pixels.

5 However, at the conventional electronic still cameras shown in Figs. 1, 2, and 3, the process to display an image on the LCD is the same as the process making the image record on the recording medium and the process to process the image in the personal computer. Therefore, the power consumption at the process making the image display on the LCD
10 becomes large being exceeded the necessity.

For example, at an electronic still camera mounted a CCD having about mega-pixels as a solid state image taking device being high definition, an image processing is executed by a high bit number being about 10 bits for the image to be displayed on the LCD.

15 Especially, at an electronic still camera used an A/D converter whose quantization bit number is large, the image processing bit number at the DSP disposed at the back stage of the A/D converter becomes large. With this, the size of the circuit becomes large and the power consumption is increased.

20 At the monitor controlling apparatus of the electronic still camera shown in Fig. 4, at the monitor through mode that the image is displayed on the LCD 836, about the half of the total pixel signals outputted from the CCD 812 are thinned out. Therefore, the number of pixels of the image to be displayed on the LCD 836 is thinned out from the
25 number of pixels of the image required a high definition image quality at the structure.

However, at the monitor controlling apparatus of the electronic still camera shown in Fig. 4, after thinned out about the half of the total pixel signals outputted from the CCD 812, at the DSP 821, a color processing is applied to about the half of the total pixel signals.
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Consequently, many alias color signals are generated in the image to be displayed on the LCD 836, and there is a problem that the image quality is deteriorated remarkably.

At the DSP 821, generally, the color processing is executed by
5 using plural pixel signals. Therefore, in case that the color processing is executed by using a part of the pixel signals outputted from the CCD 812, when each of the pixel signals is made to correspond to a subject image to be taken, each of the pixel signals is positioned at the different position on the subject to be taken. Consequently, the correlation among the pixel
10 signals used for the color processing becomes small, and many alias color signals are generated in the image to be displayed on the LCD 836.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an
15 image taking apparatus that can reduce the power consumption of the total system without deteriorating image quality when an image is displayed on an LCD.

According to a first aspect of the present invention for achieving the object mentioned above, there is provided an image taking apparatus.
20 The image taking apparatus provides a solid state image taking device which converts an optical image of a subject to be taken to analog video signals and outputs the analog video signals, an analog to digital (A/D) converter which converts at a designated quantization bit number the analog video signals outputted from the solid state image taking device to
25 digital video signals having the designated quantization bit number, a digital signal processor (DSP) which applies an image process to the digital video signals outputted from the A/D converter at a designated signal processing bit number, a displaying apparatus which displays the digital video signals outputted from the DSP, and a recording medium
30 which stores the digital video signals outputted from the DSP. And the

designated quantization bit number at the A/D converter is variable.

According to a second aspect of the present invention, in the first aspect, the A/D converter makes the quantization bit number in case that the digital video signals are displayed on the displaying apparatus 5 smaller than the quantization bit number in case that the digital video signals are stored in the recording medium.

According to a third aspect of the present invention, the image taking apparatus further provides an interface (I/F) circuit which transfers the digital video signals outputted from the DSP to the 10 recording medium in which the digital video signals are recorded, or transfers the digital video signals outputted from the DSP to an external apparatus. And the A/D converter makes the quantization bit number in case that the digital video signals are displayed on the displaying apparatus smaller than the quantization bit number in case that the 15 digital video signals are transferred to the external apparatus through the I/F circuit.

According to a fourth aspect of the present invention, in the first aspect, the signal processing bit number at the DSP is variable, and the signal processing bit number is made to be the same bit number of the 20 quantization bit number at the A/D converter in case that the digital video signals are displayed on the displaying apparatus.

According to a fifth aspect of the present invention, in the first aspect, the image taking apparatus further provides a mode setting switch for setting an operation mode at the image taking apparatus, and 25 a system controller which generates a bit number converting signal for setting the quantization bit number at the A/D converter and the signal processing bit number at the DSP based on the operation mode set at the mode setting switch, and outputs the bit number converting signal to the A/D converter and the DSP. And the A/D converter sets the 30 quantization bit number based on the bit number converting signal

outputted from the system controller, and the DSP sets the signal processing bit number based on the bit number converting signal outputted from the system controller.

According to a sixth aspect of the present invention, there is
5 provided an image taking apparatus. The image taking apparatus provides a solid state image taking device which converts an optical image of a subject to be taken to analog video signals and outputs the analog video signals, an analog to digital (A/D) converter which converts at a designated quantization bit number the analog video signals
10 outputted from the solid state image taking device to digital video signals having the designated quantization bit number, a digital signal processor (DSP) which applies an image process to the digital video signals outputted from the A/D converter at a designated signal processing bit number, a displaying apparatus which displays the digital video signals
15 outputted from the DSP, and a recording medium which stores the digital video signals outputted from the DSP. And the A/D converter provides plural A/D converting sections in which the quantization bit number of each of the plural A/D converting sections is different between them and is fixed, and either one of the plural A/D converting sections converts the
20 analog video signals outputted from the solid state image taking device to digital video signals, and outputs the digital video signals to the DSP.

According to a seventh aspect of the present invention, in the sixth aspect, the image taking apparatus further provides a switching circuit which selects one of the plural A/D converting sections that has
25 smaller quantization bit number than the other of the plural A/D converting sections which is selected at the time when the digital video signals are stored in the recording medium, in case that the digital video signals are displayed on the displaying apparatus. And the digital video signals outputted from the A/D converting section selected by the
30 switching circuit are inputted to the DSP.

According to an eighth aspect of the present invention, in the sixth aspect, the image taking apparatus further provides an interface (I/F) circuit which transfers the digital video signals outputted from the DSP to the recording medium in which the digital video signals are recorded, or transfers the digital video signals outputted from the DSP to an external apparatus. And the switching circuit, in case that the digital video signals are displayed on the displaying apparatus, selects one of the plural A/D converting sections whose quantization bit number is smaller than the other A/D converting section that is selected at the time when the digital video signals are transferred to an external apparatus through the I/F circuit.

According to ninth aspect of the present invention, in the sixth aspect, the signal processing bit number at the DSP is variable, and the signal processing bit number in case that the digital video signals are displayed on the displaying apparatus is made to be the same bit number of the quantization bit number at the A/D converting section selected by the switching circuit.

According to tenth aspect of the present invention, in the sixth aspect, the image taking apparatus further provides a mode setting switch for setting an operation mode at the image taking apparatus, and a system controller which generates an A/D converting section changing signal for switching the switching circuit based on the operation mode set by the mode setting switch and outputs the generated A/D converting section changing signal to the switching circuit, and also generates a bit number converting signal for setting the signal processing bit number at the DSP based on the operation mode set at the mode setting switch, and outputs the bit number converting signal to the DSP. And the switching circuit selects either one of the plural A/D converting sections based on the A/D converting section changing signal outputted from the system controller, and the DSP sets the signal processing bit number based on

the bit number converting signal outputted from the system controller.

According to an eleventh aspect of the present invention, the system controller, in case that the digital video signals stored in the recording medium are displayed on the displaying apparatus, stops 5 operation of the solid state image taking device, the A/D converter, and the DSP.

According to a twelfth aspect of the present invention, the mode setting switch, in case that the digital video signals have been stored in the recording medium, selects whether the digital video signals stored in 10 the recording medium are made to display on the displaying apparatus or not.

According to a thirteenth aspect of the present invention, the image taking apparatus further provides a displaying apparatus driver for making the digital video signals display on the displaying apparatus 15 by thinning out a part of the digital video signals outputted from the DSP.

According to a fourteenth aspect of the present invention, the image taking apparatus is an electronic still camera.

According to the present invention, the quantization bit number at the A/D converter is variable. Therefore, in case that a monitoring 20 image is displayed on the displaying apparatus, when the quantization bit number at the A/D converter is controlled to be smaller than that at the time when the digital video signals are stored in the recording medium or are transferred to the external apparatus, the power consumption at the A/D converter can be reduced.

According to the present invention, in case that the signal 25 processing bit number at the DSP is variable, when the monitoring image is displayed on the displaying apparatus, by setting the signal processing bit number at the DSP to equal to the quantization bit number at the A/D converter, the power consumption at the DSP can be reduced. And at 30 the back stage of the A/D converter, plural DSPs corresponding to the

quantization bit number that changes at the A/D converter are not needed to provide. With this, the circuit size of the total system of the image taking apparatus can be prevented to become large.

According to the present invention, in case that the monitoring 5 image is displayed on the displaying apparatus, the power consumption at the A/D converter and the DSP can be reduced, and also the circuit size of the total system of the image taking apparatus can be prevented to become large. Therefore, the power consumption of the total system of the image taking apparatus can be reduced largely.

10 According to the present invention, in case that the monitoring image is displayed on the displaying apparatus, after that image processes are applied to the video signals outputted from the solid state image taking device at the DSP, a thinning out image process, in which a part of the video signals is thinned out at a driver for the displaying 15 apparatus, is applied to the video signals. Therefore, the generation of color alias signals can be restrained and the deterioration of the image quality can be restrained.

BRIEF DESCRIPTION OF THE DRAWINGS

20 The objects and features of the present invention will become more apparent from the consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

25 Fig. 1 is a block diagram showing a structure of a conventional electronic still camera disclosed in Japanese Patent Application Laid-Open No. HEI 11-164178;

Fig. 2 is a block diagram showing a structure of a conventional electronic still camera disclosed in Japanese Patent Application Laid-Open No. HEI 11-136551;

30 Fig. 3 is a block diagram showing a structure of a conventional

electronic still camera disclosed in Japanese Patent Application Laid-Open No. HEI 10-276356;

Fig. 4 is a block diagram showing a structure of a monitor controlling apparatus for an electronic still camera disclosed in Japanese Patent Application Laid-Open No. HEI 9-93470;

Fig. 5 is a block diagram showing a structure of a first embodiment of an image taking apparatus of the present invention;

Fig. 6 is a diagram showing a structure of a digital signal processor of the first embodiment of the image taking apparatus of the present invention;

Fig. 7A is a diagram showing an operation sequence at a taking image mode of the first embodiment of the image taking apparatus of the present invention;

Fig. 7B is a diagram showing an operation sequence at a PC displaying mode of the first embodiment of the image taking apparatus of the present invention;

Fig. 7C is a diagram showing an operation sequence at a reproducing mode of the first embodiment of the image taking apparatus of the present invention; and

Fig. 8 is a block diagram showing a structure of a second embodiment of the image taking apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, embodiments of the present invention are explained in detail. Fig. 5 is a block diagram showing a structure of a first embodiment of an image taking apparatus of the present invention.

As shown in Fig. 5, the first embodiment of the image taking apparatus of the present invention consists of a lens 1, a diaphragm 2, a shutter 3, a solid state image taking device (CCD) 4, an analog signal

processor 5, a horizontal/vertical (H/V) driver 6, a diaphragm/shutter controller 7, an A/D converter 8, a digital signal processor (DSP) 9, a frame memory 10, an LCD driver 11, an interface (I/F) circuit 12, a timing generator (TG) 13, a system controller (hereinafter referred to as CPU) 14, 5 an LCD 15, a recording medium 16, a mode setting switch 19.

At the first embodiment of the present invention, any one of a taking image mode, a reproducing mode, and a personal computer (PC) displaying mode is selected at the mode setting switch 19.

In this, the taking image mode is, generally, an LCD displaying mode in which video signals taken at the solid state image taking device 4 are displayed on the LCD 15 as a monitoring image, and when the shutter 3 is pushed at the LCD displaying mode, the taking image mode becomes a recording mode in which video signals taken at the solid state image taking device 4 are recorded in the recording medium 16.

15 The reproducing mode signifies that the video signals recorded in the recording medium 16 are reproduced and displayed on the LCD 15, and the PC displaying mode signifies that the video signals taken at the solid state image taking device 4 are transferred to a PC (not shown).

The CPU 14, based on the selected mode at the mode setting switch 19 and an operated result of the video signals at the DSP 9, controls all functions in the image taking apparatus. For example, the CPU 14 sets a quantization bit number at the A/D converter 8, and calculates various kinds of parameters at the DSP 9 and sets a signal processing bit number for changing of signal processing of the video signals at the DSP 9, and controls the TG 13 and the diaphragm/shutter controller 7 so that an optimum image taking condition can be obtained.

The TG 13 outputs a clock signal in a designated cycle to the H/V driver 6, the analog signal processor 5, and the A/D converter 8, based on an instruction from the CPU 14.

30 The diaphragm/shutter controller 7 controls the diaphragm 2

and the shutter 3 based on an instruction from the CPU 14, and makes an optical image of a subject to be taken obtained at the lens 1 project to the solid state image taking device 4 by adjusting the distance to the optical image of the subject to be taken and the amount of light of the optical image of the subject to be taken to desired values.

The H/V driver 6 outputs a driving pulse to the solid state image taking device 4 by synchronized with the clock signal outputted from the TG 13 in a designated cycle.

The solid state image taking device 4 is a CCD in which a color filter array (not shown) is disposed in a designated arrangement on photoelectric conversion elements (not shown) arranged in two dimensions. When an optical image of a subject to be taken is projected on the photoelectric conversion elements, this optical image of the subject to be taken is converted to video signals being electric analog signals, for example, corresponding to each color of red (R), green (G), and blue (B).

And the solid state image taking device 4 provides horizontal/vertical registers (not shown) which output the video signals that the optical image of the subject to be taken was converted by the photoelectric conversion elements, based on the driving pulse outputted from the H/V driver 6. With this, the solid state image taking device 4 outputs the video signals by synchronized with the clock signal outputted from the TG 13. The analog signal processor 5 removes noise such as reset noise and shot noise caused by dark current which are included in the video signals outputted from the solid state image taking device 4, by synchronized with the clock signal outputted from the TG 13, and outputs the video signals in which the noise was removed.

The A/D converter 8 converts the video signals outputted from the analog signal processor 5 to digital video signals by a designated quantization bit number by synchronized with the clock signal outputted from the TG 13, and outputs the digital video signals to the DSP 9. In

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this, the quantization bit number is variable at the A/D converter 8, and the quantization bit number is changed by a bit number converting signal 17 outputted from the CPU 14.

At the first embodiment of the present invention, the solid state image taking device 4, the analog signal processor 5, and the A/D converter 8 are operated by synchronized with the clock signal outputted from the TG 13. With this, all the video signals outputted from the solid state image taking device 4 are converted to the digital video signals at the A/D converter 8 by the designated quantization bit number.

Fig. 6 is a diagram showing a structure of the DSP 9 of the first embodiment of the image taking apparatus of the present invention. As shown in Fig. 6, the DSP 9 consists of a color separation circuit 201, a color correction circuit 202, a white balance circuit 203, a contour compensation circuit 204, a gamma correction circuit 205, and a clip circuit 206.

The color separation circuit 201 applies a color interpolation process (color process) to the digital video signals outputted from the A/D converter 8 and converts the video signals outputted from the A/D converter 8 to color video signals and outputs the color video signals. For example, when video signals corresponding to R, G, and B are outputted from the solid state image taking device 4, at the color separation circuit 201, the video signals outputted from the A/D converter 8 are converted to color video signals composed of a R signal, a G signal, and a B signal.

The color correction circuit 202 applies a linear matrix process to the color video signals outputted from the color separation circuit 201 in order to improve the color reproducibility. And the white balance circuit 203 adjusts a gain of the color video signals applied the linear matrix process at the color correction circuit 202 so that a designated color reproducibility can be always kept regardless of the lightning

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condition at the image taking.

The contour compensation circuit 204 compensates contours of the color video signals whose gain were adjusted at the white balance circuit 203 in order to improve the sharpness of the image. And the 5 gamma correction circuit 205 applies a non-linear process to the color video signals whose contours were compensated at the contour compensation circuit 204 in order to meet input and output characteristics of the LCD 15.

The clip circuit 206 removes color video signals that did not 10 reach a designated gradation level from the color video signals applied the non-linear process at the gamma correction circuit 205.

The DSP 9 applies the various image processes mentioned above by the designated signal processing bit number to the color video signals outputted from the A/D converter 8 and outputs color video 15 signals generated at the image processes mentioned above. In this, the signal processing bit number at the DSP 9 changes based on the bit number converting signal 17 supplied from the CPU 14, and is set to be the same bit number that the quantization bit number at the A/D converter 8.

At the first embodiment of the present invention, the bit 20 number converting signal 17 outputted from the CPU 14 is directly inputted to the A/D converter 8 and the DSP 9. However, the bit number converting signal 17 outputted from the CPU 14 can be inputted to the A/D converter 8 and the DSP 9 through an internal bus 18.

The color video signals outputted from the DSP 9 are inputted 25 to the LCD driver 11, the I/F circuit 12, the frame memory 10, and the CPU 14 through the internal bus 18.

The frame memory 10 stores the color video signals outputted 30 from the DSP 9 temporarily and outputs the color video signals to the LCD driver 11, the I/F circuit 12, and the CPU 14 corresponding to the

necessity.

The LCD driver 11 applies a process, in which these color video signals are made to display on the LCD 15, to the color video signals outputted from the DSP 9 and makes the color video signals applied the 5 process display on the LCD 15.

Generally, the number of pixels of the video signals outputted from the solid state image taking device 4 is larger than the number of pixels required to display on the LCD 15. Therefore, the processes at the LCD diver 11 include a process to thin out a part of data of the color 10 video signals outputted from the DSP 9.

At the Japanese Patent Application Laid-Open No. HEI 9-93470, the color interpolation process is applied to video signals thinned out from the video signals outputted from the solid state image taking device 4. Therefore the color alias signals are generated largely, as a 15 result, the image quality is deteriorated remarkably.

However, at the first embodiment of the present invention, the color interpolation process is executed at the color separation circuit 201 provided in the DSP 9 for all the video signals outputted from the solid state image taking device 4. After this, the thinning out process of the 20 color video signals is executed at the LCD driver 11. Therefore, the generation of the color alias signals can be restrained and the deterioration of the image quality can be prevented.

The I/F circuit 12 is an interface circuit executing a process that makes the color video signals outputted from the DSP 9 record in the 25 recording medium 16 such as a memory card, a hard disk, and a magnetic tape.

At the first embodiment of the present invention, the I/F circuit 12 can be used as not only an interface circuit to record the color video signals in the recording medium 16 but also as an external bus interface 30 circuit connecting to a PC and a printer, for example, as an IEEE 1394, a

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universal serial bus (USB), and a small computer system interface (SCSI).

Next, referring to drawings, operation of the first embodiment of the image taking apparatus of the present invention is explained. Fig.

- 5 7A is a diagram showing an operation sequence at the taking image mode of the first embodiment of the image taking apparatus of the present invention. Fig. 7B is a diagram showing an operation sequence at the PC displaying mode of the first embodiment of the image taking apparatus of the present invention. Fig. 7C is a diagram showing an
10 operation sequence at the reproducing mode of the first embodiment of the image taking apparatus of the present invention.

First, the operation sequence at the taking image mode shown in Fig. 7A is explained. After power (not shown) is turned on, when the taking image mode is selected at the mode setting switch 19, at the functions in the image taking apparatus, in order that a photographer is made to monitor a subject to be taken, operation of a LCD displaying mode displaying a monitoring image on the LCD 15 is executed.

- 15 In this, even after the taking image mode is selected at the mode setting switch 19, when the power is turned on, at the functions in
20 the image taking apparatus, the operation of the LCD displaying mode displaying the monitoring image on the LCD 15 is executed.

- When the taking image mode is selected at the mode setting switch 19, the CPU 14 outputs the bit number converting signal 17, with which the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are set to be 8 bits, to the A/D converter 8 and the DSP 9. With this, the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are set to be 8 bits.

- The CPU 14 controls the TG 13 and the diaphragm/shutter controller 7 at the same time of outputting the bit number converting

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signal 17. With this, the TG 13 outputs a clock signal in a designated cycle, and the diaphragm/shutter controller 7 controls the diaphragm 2 and the shutter 3.

By controlling the diaphragm 2 and the shutter 3 at the 5 diaphragm/shutter controller 7, the distance and the amount of light of the optical image of the subject to be taken obtained at the lens 1 are adjusted to required values and the adjusted optical image is projected on the solid state image taking device 4.

At the solid state image taking device 4, the optical image of the 10 subject to be taken is projected on the surface of the photoelectric conversion elements provided in the solid state image taking device 4. And this optical image of the subject to be taken is converted to video signals being analog electric signals by the photoelectric conversion elements.

15 At this time, at the H/V driver 6, driving pulses are generated by synchronized with the clock signal outputted from the TG 13 in a designated cycle. And the generated driving pulses are outputted to the H/V registers provided in the solid state image taking device 4.

With this, at the solid state image taking device 4, the H/V 20 registers provided in the solid state image taking device 4 output the video signals by synchronized with the driving pulses outputted from the H/V drivers 6.

Next, at the analog signal processor 5, noise included in the video signals outputted from the solid state image taking device 4 is 25 removed by synchronized with the clock signal outputted from the TG 13, and the video signals from which the noise was removed are outputted to the A/D converter 8. At the A/D converter 8, the quantization bit number has been set to be 8 bits by the bit number converting signal 17 outputted from the CPU 14. With this, the video signals outputted from 30 the analog signal processor 5 are converted to the video signals of 8 bits

by synchronized with the clock signal outputted from the TG 13 in a designated cycle, and the converted 8 bits video signals are outputted to the DSP 9.

At the DSP 9, first, at the color separation circuit 201, the color
5 interpolation process (color process) is applied to the digital video signals outputted from the A/D converter 8. With this, the video signals outputted from the A/D converter 8 are converted to color video signals.

After this, the linear matrix process is applied to the color video signals, which were applied the color interpolation process at the color
10 separation circuit 201, at the color correction circuit 202. And the gain of the color video signals is adjusted at the white balance circuit 203. And the contour of the image of the color video signals is compensated at the contour compensation circuit 204, and after this the non-linear process is applied to the color video signals outputted from the contour
15 compensation circuit 204 at the gamma correction circuit 205.

And at the clip circuit 206, the color video signals that did not reach a designated gradation level are removed from the color video signals applied the non-linear process at the gamma correction circuit 205.

20 At the DSP 9, the signal processing bit number has been set to be 8 bits as the same as the quantization bit number at the A/D converter 8 by the bit number converting signal 17 outputted from the CPU 14. With this, various image processes mentioned above are applied to the video signals outputted from the A/D converter 8 at 8 bits, and the color
25 video signals generated by the various image processes are outputted from the DSP 9.

The color video signals outputted from the DSP 9 are inputted to the LCD driver 11, the I/F circuit 12, the frame memory 10, and the CPU 14 through the internal bus 18.

30 After this, at the LCD driver 11, processes including a part of

the color video signals thinning out process so that this color video signals are displayed on the LCD 15 are applied to this color video signals outputted from the DSP 9. With this, the color video signals being the monitoring image are displayed on the LCD 15.

5 At this time, when the photographer pushes the shutter 3 by specified a subject to be taken, a recording mode, which records an optical image of the subject to be taken projected on the solid state image taking device 4 at the time when the shutter 3 was pushed in the recording medium 16, is executed, at the functions provided in the image taking
10 apparatus.

At the recording mode, first, the CPU 14 outputs a bit number converting signal 17, which changes the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 to 10 bits, to the A/D converter 8 and the DSP 9. With this, the quantization
15 bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are changed to 10 bits respectively.

Next, at the solid state image taking device 4, the optical image of the subject to be taken projected on the surface of the photoelectric conversion elements at the time when the shutter 3 was pushed is converted to video signals being analog electric signals by the photoelectric conversion elements and the converted video signals are outputted.
20

Next, at the analog signal processor 5, noise including in the video signals outputted from the solid state image taking device 4 is removed by synchronized with the clock signal outputted from the TG 13, and the video signals whose noise was removed are outputted to the A/D converter 8. At the A/D converter 8, the quantization bit number has been set to be 10 bits by the bit number converting signal 17 outputted from the CPU 14. With this, the video signals outputted from the analog
30 signal processor 5 are converted to video signals of 10 bits by

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synchronized with the clock signal outputted from the TG 13, and the converted video signals are outputted to the DSP 9.

At the DSP 9, the signal processing bit number has been set to be 10 bits that is the same as the quantization bit number at the A/D converter 8 by the bit number converting signal 17 outputted from the CPU 14. With this, an image processing of 10 bits is applied to the video signals outputted from the A/D converter 8, and color video signals are generated and outputted.

The color video signals outputted from the DSP 9 are inputted to the LCD driver 11, the I/F circuit 12, the frame memory 10, and the CPU 14 through the internal bus 18.

At the I/F circuit 12, a process to record this color video signals in the recording medium 16 is applied to the color video signals outputted from the DSP 9, and the color video signals are recorded in the recording medium 16.

At the first embodiment of the present invention, at the recording mode that the color video signals are recorded in the recording medium 16, it is possible that the color video signals that are being recorded in the recording medium 16 are displayed on the LCD 15. In this, in case that the color video signals that are being recorded in the recording medium 16 are displayed on the LCD 15, the color video signals displaying on the LCD 15 become the color video signals processed at 10 bits at the A/D converter 8 and the DSP 9.

And at the first embodiment of the present invention, at the recording mode, it is possible that the photographer selects whether the color video signals that are being recorded in the recording medium 16 are displayed on the LCD 15 or not by using the mode setting switch 19.

When recording the color video signals in the recording medium 16 is completed, in order to take a next image, the CPU 14 outputs a bit number converting signal 17, which changes the quantization bit number

at the A/D converter 8 and the signal processing bit number at the DSP 9 to 8 bits again, to the A/D converter 8 and the DSP 9. With this, the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are changed to 8 bits respectively. This
5 signifies that the mode returns the LCD displaying mode.

Next, the operation sequence at the PC displaying mode shown in Fig. 7B is explained. In this, the operation is explained below. After power is turned on, a taking image mode is selected at the mode setting switch 19 and a monitoring image is displayed on the LCD 15. And the
10 PC displaying mode is selected at the mode setting switch 19 during the monitoring image is displaying on the LCD 15. In case that the PC displaying mode is directly selected at the mode setting switch 19 without selecting the taking image mode, the equivalent operation is executed.

When the PC displaying mode is selected during the monitoring
15 image is displaying on the LCD 15, at the functions of the image taking apparatus of the present invention, image data of color video signals are transferred to a personal computer (PC) (not shown) through the I/F circuit 12.

The CPU 14 controls the LCD driver 11 through the internal
20 bus 18 so that the LCD 15 becomes off, with this, the LCD 15 is turned off.

In this, in case that the monitoring image is displaying on the LCD 15, the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are 8 bits respectively.

Therefore, the CPU 14 outputs the bit number converting signal 17, which changes the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 to 10 bits, to the A/D converter 8 and the DSP 9, at the same time of controlling the LCD driver 11. With this, the quantization bit number at the A/D
30 converter 8 and the signal processing bit number at the DSP 9 are

changed to 10 bits respectively.

After this, in the functions in the image taking apparatus of the present invention, at the PC displaying mode, the same operation as the recording mode at the taking image mode shown in Fig. 7A, is executed
5 until the color video signals are outputted from the DSP 9.

In this, the color video signals outputted from the DSP 9 are color video signals processed at that the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are 10 bits respectively.

10 At the I/F circuit 12, the color video signals outputted from the DSP 9 are converted to a format being able to be processed at the PC and the converted color video signals are transferred to the PC.

Therefore, at the PC displaying mode, the I/F circuit 12 works as an external bus interface to the PC or a printer.

15 Next, the operation sequence at the reproducing mode shown in Fig. 7C is explained. When the reproducing mode is selected at the mode setting switch 19, at the functions of the image taking apparatus of the present invention, operation is executed at the state that the quantization bit number at the A/D converter 8 and the signal processing
20 bit number at the DSP 9 are 10 bits respectively, as the same as at the recording mode shown in Fig. 7A, and the PC displaying mode shown in Fig. 7B. And a process to display the color video signals stored in such as the recording medium 16, the frame memory 10, and a hard disk (not shown) in the PC on the LCD 15 by reproducing is executed. In this, a
25 case, in which the color video signals stored in the recording medium 16 are reproduced and displayed on the LCD 15, is explained. At a case in which the color video signals stored in the frame memory 10 or the hard disk of the PC are reproduced and displayed on the LCD 15, the equivalent operation is also executed.

30 The internal bus 18 is controlled by the CPU 14, and the color

video signals stored in the recording medium 16 are read out through the I/F circuit 12, and the read out color video signals are transferred to the LCD driver 11.

At the LCD driver 11, processes including a thinning out process, in which a part of the color video signals is thinned out to display the color video signals on the LCD 15, is applied to the color video signals transferred from the recording medium 16. With this process, the color video signals stored in the recording medium 16 are reproduced and displayed on the LCD 15.

As mentioned above, at the reproducing mode, the color video signals are reproduced and displayed on the LCD 15, at the state that the solid state image taking device 4, the analog signal processor 5, the A/D converter 8, and the DSP 9 are not made to work.

At the reproducing mode, the first embodiment of the present invention has a structure that the operation at the solid state image taking device 4, the analog signal processor 5, the A/D converter 8, and the DSP 9 is stopped by the CPU 14. Therefore, the power consumption of the functions not related to the operation at the reproducing mode can be reduced.

Further, at the reproducing mode of the first embodiment of the present invention, the changing operation, in which the quantization bit number at the A/D converter 8 and the signal processing bit number at the DSP 9 are changed, is not needed, therefore, the bit number converting signal 17 is not outputted from the CPU 14.

At the first embodiment of the present invention, as an example of the operation sequences, the operation sequences shown in Figs. 7A, 7B, and 7C are explained, however, the other operation sequences can be used within the scope and spirit of the present invention.

As mentioned at the first embodiment of the present invention, the quantization bit number at the A/D converter 8 is variable.

Therefore, at the LCD displaying mode, the power consumption at the A/D converter 8 can be reduced by that the quantization bit number at the A/D converter 8 is controlled to reduce.

Further, the signal processing bit number at the DSP 9 is
5 variable, therefore, at the LCD displaying mode, the power consumption at the DSP 9 can be reduced by that the signal processing bit number at the DSP 9 is reduced to the equivalent number of the quantization bit number at the A/D converter 8. Moreover, at the back stage of the A/D converter 8, plural DSPs are not needed to provide corresponding to the
10 changing quantization bit number at the A/D converter 8. Therefore, the circuit size of the total system of the image taking apparatus is not made to be large.

As mentioned above, at the LCD displaying mode, the power consumption at the A/D converter 8 and the DSP 9 is reduced, and also
15 the circuit size of the total system of the image taking apparatus is not made to be large, therefore, the power consumption of the total system of the image taking apparatus is largely reduced.

And at the LCD displaying mode, in case that the amount of data of the video signals outputted from the solid state image taking
20 device 4 is reduced, after the color interpolation process is applied to all the video signals outputted from the solid state image taking device 4 at the DSP 9, a thinning out process that a part of all the video signals is thinned out is applied at the LCD driver 11. With this process, the generation of color alias signals is restrained, and the deterioration of the
25 image quality of the image displaying on the LCD 15 can be prevented.

Next, referring to a drawing, a second embodiment of the image taking apparatus of the present invention is explained. Fig. 8 is a block diagram showing a structure of the second embodiment of the image taking apparatus of the present invention.

30 At the second embodiment, a function that is equivalent to the

function at the first embodiment has the same reference number that the first embodiment has. As shown in Fig. 8, at the second embodiment of the image taking apparatus of the present invention, A/D converters 20, and 21 are provided instead of the A/D converter 8 at the first embodiment, and a switching circuit 22 is newly added. Each of the A/D converters 20 and 21 provides a fixed quantization bit number being different between them respectively. The switching circuit 22 selects one of the A/D converters 20 and 21.

At the second embodiment of the present invention, the quantization bit number at the A/D converter 20 is set to be 10 bits, and the quantization bit number at the A/D converter 21 is set to be 8 bits.

The CPU 14 outputs an A/D converter changing signal 23 to the switching circuit 22 for making the switching circuit 22 switch, and controls the switching circuit 22 by this A/D converter changing signal 23.

The second embodiment of the present invention has a structure that the A/D converter changing signal 23 outputted from the CPU 14 is directly inputted to the switching circuit 22. However, the A/D converter changing signal 23 outputted from the CPU 14 can be inputted to the switching circuit 22 through the internal bus 18.

Operation of the second embodiment of the image taking apparatus of the present invention is explained.

At the LCD displaying mode, the CPU 14 outputs the A/D converter changing signal 23 for connecting the analog signal processor 5 and the A/D converter 21 to the switching circuit 22, and also outputs the bit number converting signal 17 for changing the signal processing bit number at the DSP 9 to 8 bits being equivalent to the quantization bit number at the A/D converter 21.

With this operation, the switching circuit 22 is changed over, and the analog signal processor 5 and the A/D converter 21 are connected, and the signal processing bit number at the DSP 9 is set to 8 bits being

equivalent to the quantization bit number at the A/D converter 21.

After this, at the A/D converter 21, the video signals outputted from the analog signal processor 5 are converted to the video signals being 8 bits and the 8 bit video signals are outputted. And at the DSP 9, 5 an image process is applied to the video signals outputted from the A/D converter 21 at 8 bits.

At the recording mode and the PC displaying mode, the CPU 14 outputs the A/D converter changing signal 23 for connecting the analog signal processor 5 and the A/D converter 20 to the switching circuit 22, 10 and also outputs the bit number converting signal 17 for changing the signal processing bit number at the DSP 9 to 10 bits being equivalent to the quantization bit number at the A/D converter 20.

With this operation, the switching circuit 22 is changed over, and the analog signal processor 5 and the A/D converter 20 are connected, 15 and the signal processing bit number at the DSP 9 is set to 10 bits being equivalent to the quantization bit number at the A/D converter 20.

After this, at the A/D converter 20, the video signals outputted from the analog signal processor 5 are converted to the video signals being 10 bits and the 10 bit video signals are outputted. And at the DSP 9, 20 an image process is applied to the video signals outputted from the A/D converter 20 at 10 bits.

As mentioned above, at the second embodiment of the present invention, the structure, in which the video signals outputted from the analog signal processor 5 are converted to digital video signals, is only 25 different from the first embodiment. And the other functions and operation are the same that the first embodiment has, therefore, the detailed explanation is omitted. And at the second embodiment, operation at the reproducing mode is the same as the first embodiment.

At the first and second embodiments of the present invention, 30 the structure and operation are explained as that the image taking

apparatus is the electronic still camera, however, the image taking apparatus of the present invention can be also applied to the other apparatuses not be the electronic still camera.

And at the first and second embodiments of the present invention, the structure and operation of the displaying apparatus for displaying images is explained as that the displaying apparatus is an LCD. However, the other displaying apparatuses not be the LCD can be also used as the displaying apparatus at the present invention.

And at the first and second embodiments of the present invention, the cases, in which the quantization bit number at the LCD displaying mode is set to be 8 bits and the quantization bit number at the recording mode and the PC displaying mode is set to be 10 bits, are explained. However, at the present invention, the quantization bit number at the LCD displaying mode can be set to be an arbitrary number at the condition that the quantization bit number at the LCD displaying mode is smaller than that at the recording mode and the PC dispalying mode.

And at the first and second embodiments of the present invention, a structure, in which an analog process such as removing noise at an analog signal processor is applied to video signals outputted from a solid state image taking device and after this analog to digital conversion is applied to the video signals at an A/D converter, is explained. However, at the present invention, a structure, in which first the analog to digital conversion is applied to the video signals outputted from the solid state image taking device at an A/D converter and after this the digital process such as removing noise at an DSP is applied to the video signals, can be used.

As mentioned above, according to the present invention, the quantization bit number at an A/D converter is variable. Therefore, in case that a monitoring image is displayed on a displaying apparatus

being at a displaying mode, when the quantization bit number at the A/D converter is controlled to be smaller than that at a recording mode or a PC displaying mode, the power consumption at the A/D converter can be reduced.

5 And in case that the signal processing bit number at a DSP is variable, when a monitoring image is displayed on a displaying apparatus, by setting the signal processing bit number at the DSP to equal to the quantization bit number at the A/D converter, the power consumption at the DSP can be reduced. And at the back stage of the A/D converter,
10 plural DSPs corresponding to the quantization bit number that changes at the A/D converter are not needed to provide. With this, the circuit size of the total system of the image taking apparatus can be prevented to become large.

As mentioned above, in case that the monitoring image is displayed on the displaying apparatus, the power consumption at the A/D converter and the DSP can be reduced, and also the circuit size of the total system of the image taking apparatus can be prevented to become large. Therefore, the power consumption of the total system of the image taking apparatus can be reduced largely.

20 And in case that the monitoring image is displayed on the displaying apparatus, after that image processes are applied to the video signals outputted from the solid state image taking device at the DSP, a thinning out image process, in which a part of the video signals is thinned out at a driver for the displaying apparatus, is applied to the video signals.
25 Therefore, the generation of color alias signals can be restrained and the deterioration of the image quality can be restrained.

While the present invention has been described with reference to the particular illustrative embodiments, it is not to be restricted by those embodiments but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the

embodiments without departing from the scope and spirit of the present invention.

WHAT IS CLAIMED IS:

1. An image taking apparatus, comprising:

a solid state image taking device which converts an optical image of a subject to be taken to analog video signals and outputs said analog video signals;

5 an analog to digital (A/D) converter which converts at a designated quantization bit number said analog video signals outputted from said solid state image taking device to digital video signals having said designated quantization bit number;

a digital signal processor (DSP) which applies an image process

10 to said digital video signals outputted from said A/D converter at a designated signal processing bit number;

a displaying apparatus which displays said digital video signals outputted from said DSP; and

15 a recording medium which stores said digital video signals outputted from said DSP, wherein:

said designated quantization bit number at said A/D converter is variable.

2. An image taking apparatus in accordance with claim 1, wherein:

5 said A/D converter makes said quantization bit number in case that said digital video signals are displayed on said displaying apparatus smaller than the quantization bit number in case that said digital video signals are stored in said recording medium.

3. An image taking apparatus in accordance with claim 1, further comprising:

an interface (I/F) circuit which transfers said digital video signals outputted from said DSP to said recording medium in which said

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5 digital video signals are recorded, or transfers said digital video signals outputted from said DSP to an external apparatus, wherein:

10 said A/D converter makes said quantization bit number in case that said digital video signals are displayed on said displaying apparatus smaller than the quantization bit number in case that said digital video signals are transferred to said external apparatus through said I/F circuit.

4. An image taking apparatus in accordance with claim 1, wherein:

5 said signal processing bit number at said DSP is variable, and said signal processing bit number is made to be the same bit number of said quantization bit number at said A/D converter, in case that said digital video signals are displayed on said displaying apparatus.

5. An image taking apparatus in accordance with claim 1, further comprising:

a mode setting switch for setting an operation mode at said image taking apparatus; and

5 a system controller which generates a bit number converting signal for setting said quantization bit number at said A/D converter and said signal processing bit number at said DSP based on said operation mode set at said mode setting switch, and outputs said bit number converting signal to said A/D converter and said DSP, wherein:

10 said A/D converter sets said quantization bit number based on said bit number converting signal outputted from said system controller; and

said DSP sets said signal processing bit number based on said bit number converting signal outputted from said system controller.

6. An image taking apparatus in accordance with claim 5,
wherein:

5 said system controller, in case that said digital video signals stored in said recording medium are displayed on said displaying apparatus, stops operation of said solid state image taking device, said A/D converter, and said DSP.

7. An image taking apparatus in accordance with claim 5,
wherein:

5 said mode setting switch, in case that said digital video signals have been stored in said recording medium, selects whether said digital video signals stored in said recording medium are made to display on said displaying apparatus or not.

8. An image taking apparatus in accordance with claim 1,
further comprising:

5 a displaying apparatus driver for making said digital video signals display on said displaying apparatus by thinning out a part of said digital video signals outputted from said DSP.

9. An image taking apparatus in accordance with claim 1,
wherein:

said image taking apparatus is an electronic still camera.

10. An image taking apparatus, comprising:

a solid state image taking device which converts an optical image of a subject to be taken to analog video signals and outputs said analog video signals;

5 an analog to digital (A/D) converter which converts at a designated quantization bit number said analog video signals outputted

from said solid state image taking device to digital video signals having said designated quantization bit number;

10 a digital signal processor (DSP) which applies an image process to said digital video signals outputted from said A/D converter at a designated signal processing bit number;

 a displaying apparatus which displays said digital video signals outputted from said DSP; and

15 a recording medium which stores said digital video signals outputted from said DSP, wherein:

 said A/D converter provides plural A/D converting sections in which the quantization bit number of each of said plural A/D converting sections is different between them and is fixed, and either one of said plural A/D converting sections converts said analog video signals 20 outputted from said solid state image taking device to digital video signals, and outputs said digital video signals to said DSP.

11. An image taking apparatus in accordance with claim 10, further comprising:

5 a switching circuit which selects one of said plural A/D converting sections that has smaller quantization bit number than the other of said plural A/D converting sections which is selected at the time when said digital video signals are stored in said recording medium, in case that said digital video signals are displayed on said displaying apparatus, wherein:

10 said digital video signals outputted from said A/D converting section selected by said switching circuit are inputted to said DSP.

12. An image taking apparatus in accordance with claim 10, further comprising:

 an interface (I/F) circuit which transfers said digital video

signals outputted from said DSP to said recording medium in which said
5 digital video signals are recorded, or transfers said digital video signals
outputted from said DSP to an external apparatus, wherein:

10 said switching circuit, in case that said digital video signals are
displayed on said displaying apparatus, selects one of said plural A/D
converting sections whose quantization bit number is smaller than the
other A/D converting section that is selected at the time when said digital
video signals are transferred to an external apparatus through said I/F
circuit.

13. An image taking apparatus in accordance with claim 10,
wherein:

5 said signal processing bit number at said DSP is variable, and
said signal processing bit number in case that said digital video signals
are displayed on said displaying apparatus is made to be the same bit
number of said quantization bit number at said A/D converting section
selected by said switching circuit.

14. An image taking apparatus in accordance with claim 10,
further comprising:

a mode setting switch for setting an operation mode at said
image taking apparatus; and

5 a system controller which generates an A/D converting section
changing signal for switching said switching circuit based on said
operation mode set by said mode setting switch and outputs said
generated A/D converting section changing signal to said switching circuit,
and also generates a bit number converting signal for setting said signal
processing bit number at said DSP based on said operation mode set at
10 said mode setting switch, and outputs said bit number converting signal
to said DSP, wherein:

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15 said switching circuit selects either one of said plural A/D converting sections based on said A/D converting section changing signal outputted from said system controller; and

said DSP sets said signal processing bit number based on said bit number converting signal outputted from said system controller.

15. An image taking apparatus in accordance with claim 14, wherein:

said system controller, in case that said digital video signals stored in said recording medium are displayed on said displaying apparatus, stops operation of said solid state image taking device, said A/D converter, and said DSP.

16. An image taking apparatus in accordance with claim 14, wherein:

said mode setting switch, in case that said digital video signals have been stored in said recording medium, selects whether said digital video signals stored in said recording medium are made to display on said displaying apparatus or not.

17. An image taking apparatus in accordance with claim 10, further comprising:

a displaying apparatus driver for making said digital video signals display on said displaying apparatus by thinning out a part of said digital video signals outputted from said DSP.

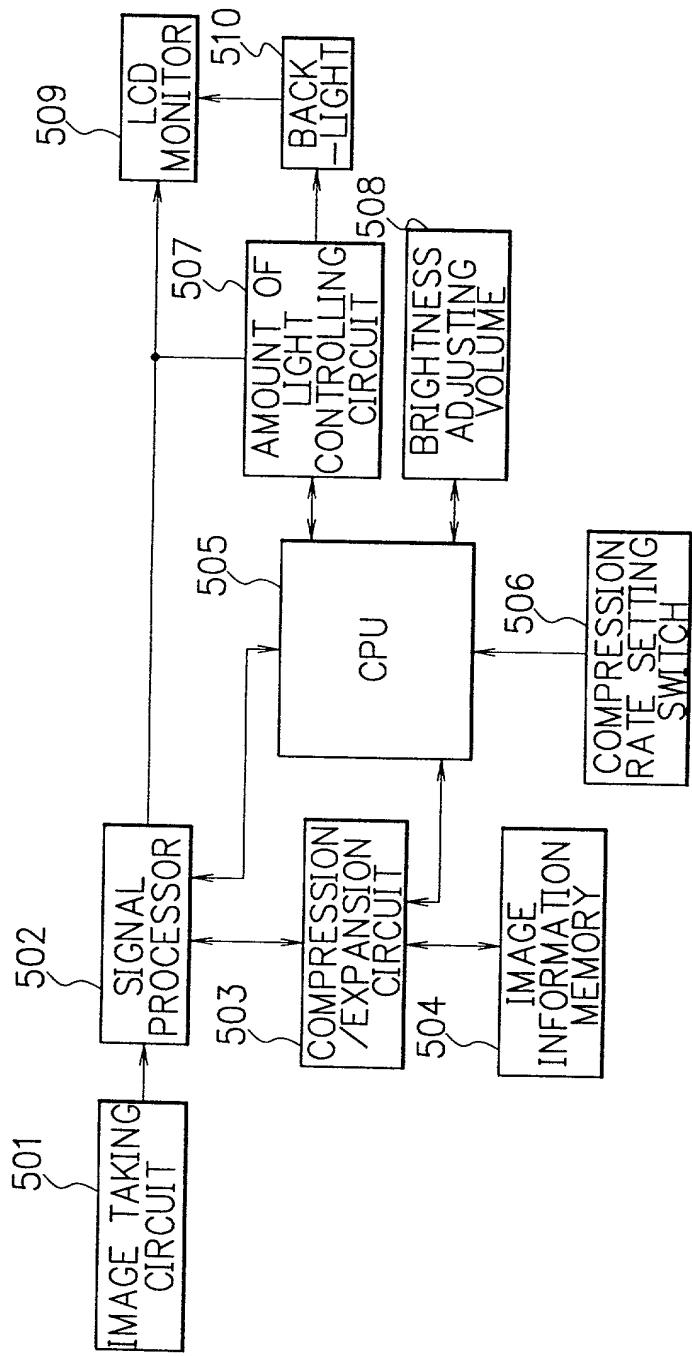
18. An image taking apparatus in accordance with claim 10, wherein:

said image taking apparatus is an electronic still camera.

ABSTRACT OF THE DISCLOSURE

An image taking apparatus, which can reduce the power consumption of the total system of the image taking apparatus without deteriorating image quality when an image is displayed on a liquid crystal display (LCD), is provided. In the image taking apparatus, the quantization bit number at an analog to digital (A/D) converter and the signal processing bit number at a digital signal processor (DSP) are variable. With this, at an LCD displaying mode that video signals are displayed on the LCD, the quantization bit number at the A/D converter is reduced and also the signal processing bit number at the DSP is reduced to the same bit number at the A/D converter. With this operation, at the LCD displaying mode, the power consumption at the A/D converter and the DSP is reduced, therefore the power consumption of the total system of the image taking apparatus is largely reduced.

F I G. 1
PRIOR ART



F I G. 2

PRIOR ART

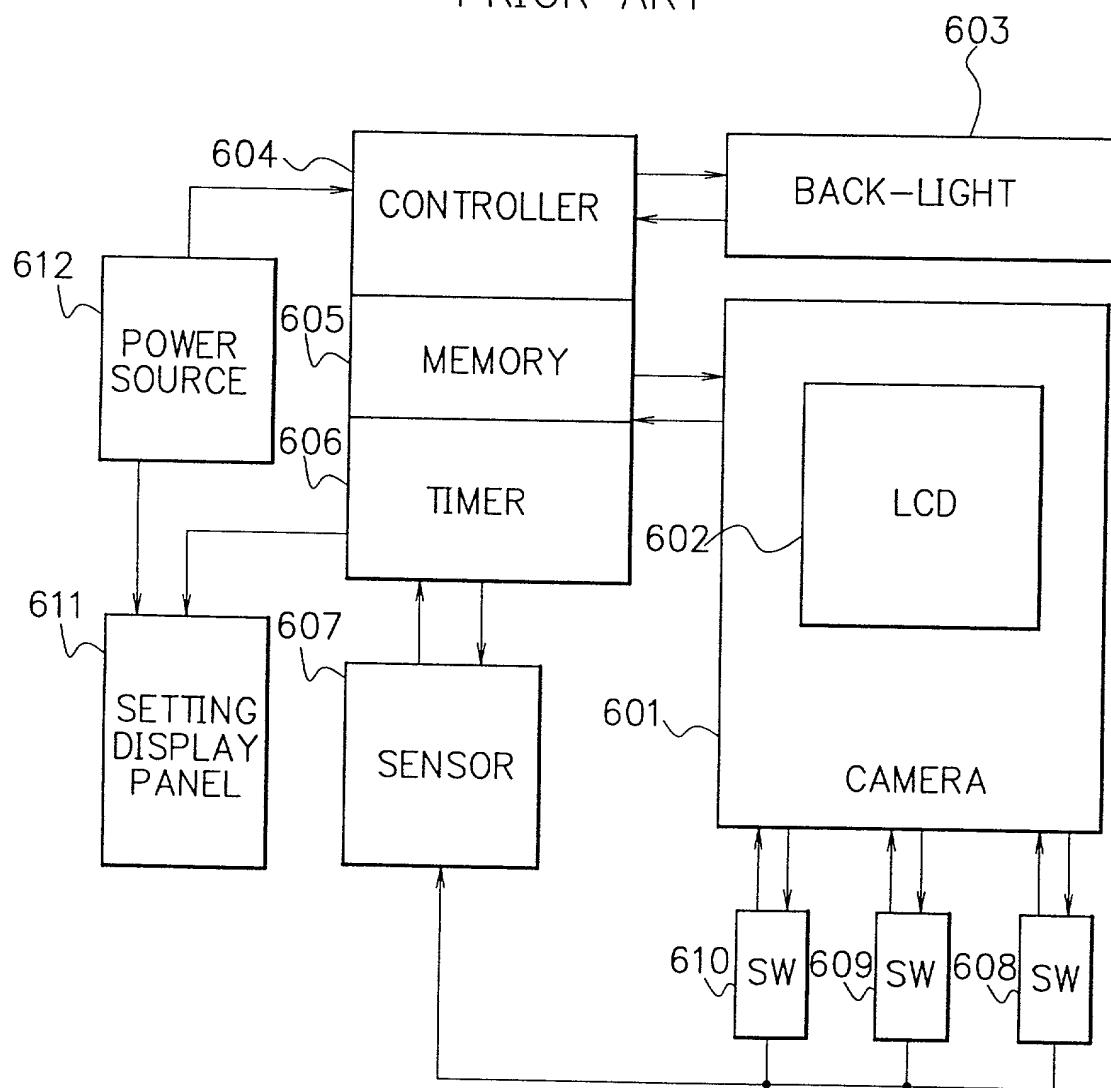
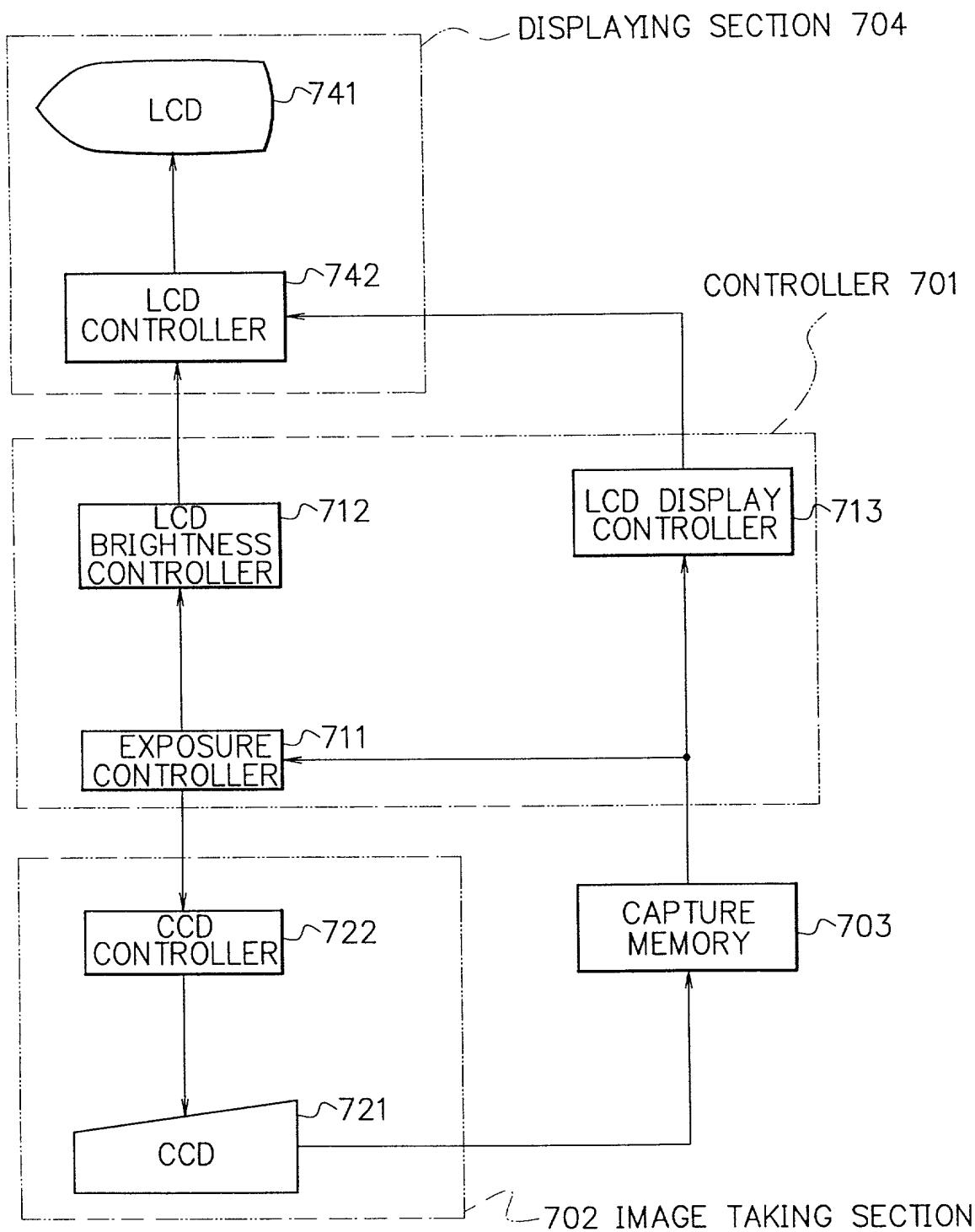


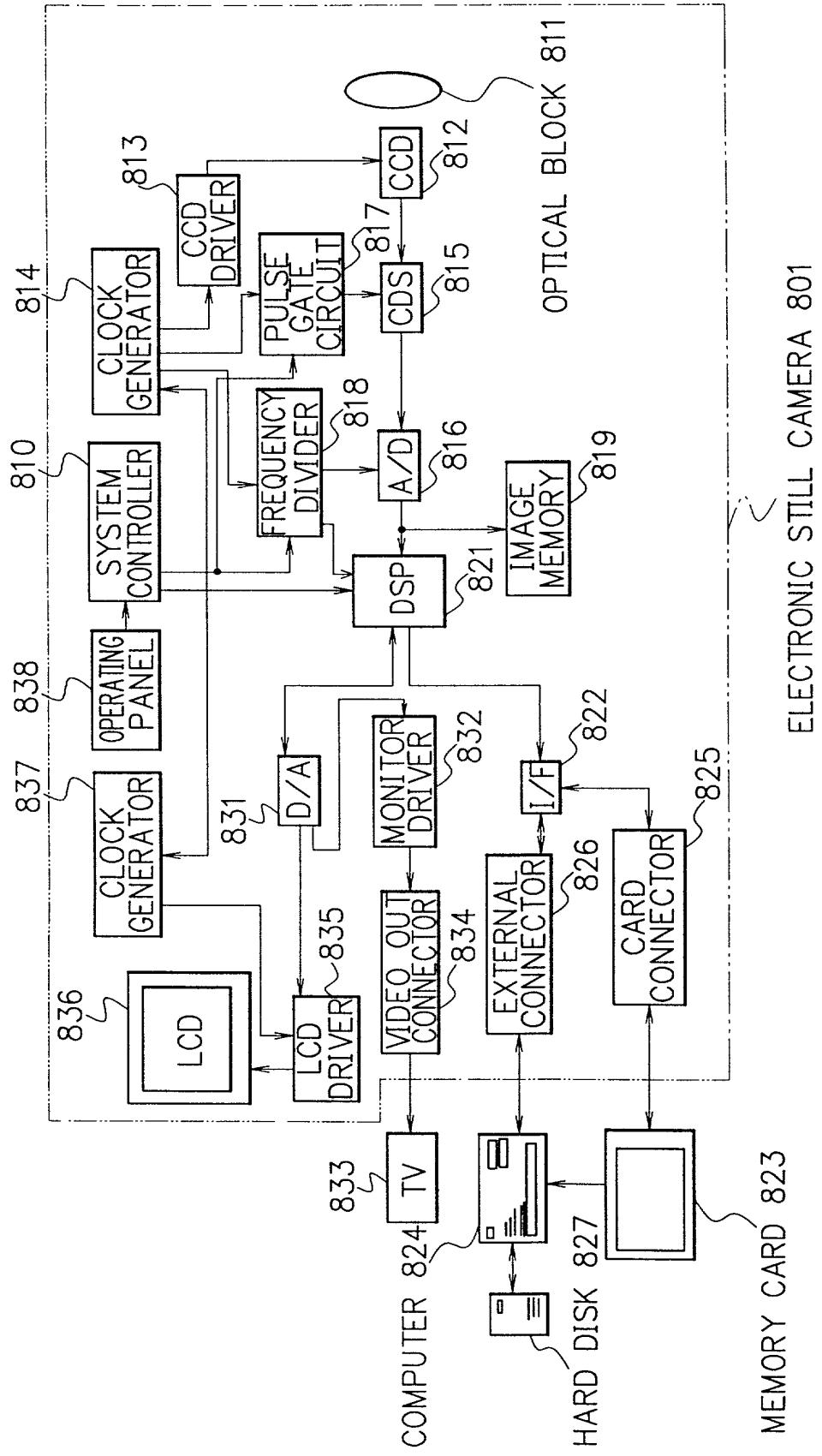
FIG. 3
PRIOR ART

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F I G. 4

PRIOR ART



ELECTRONIC STILL CAMERA 801

FIG. 5

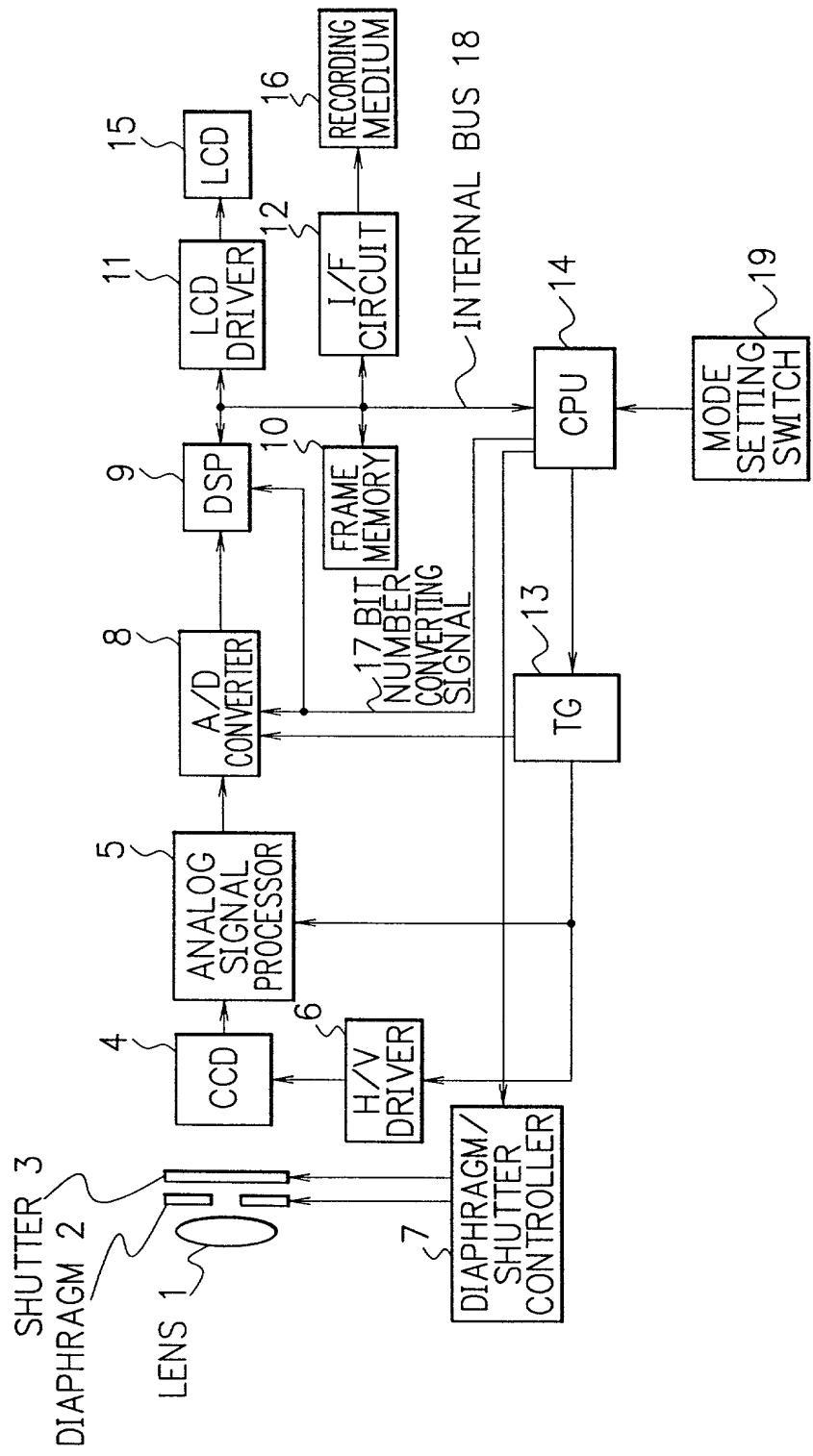
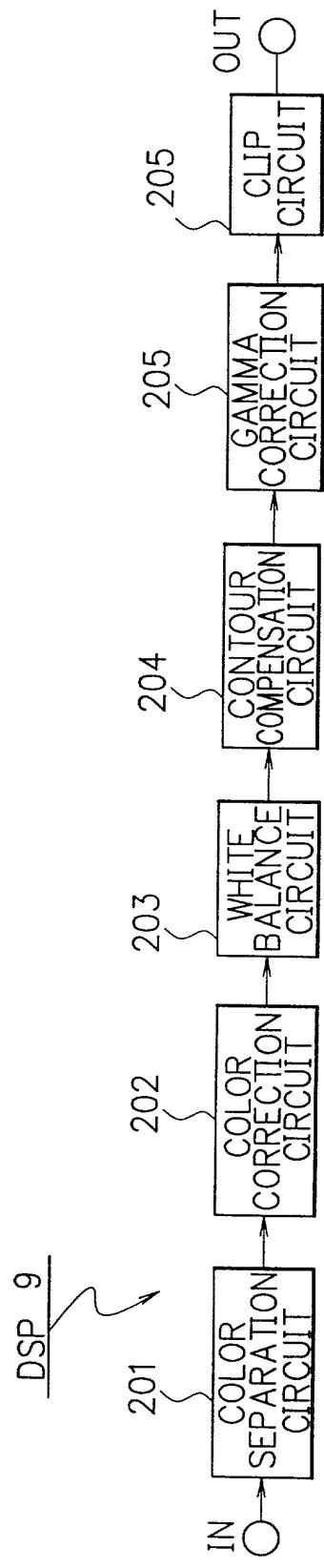


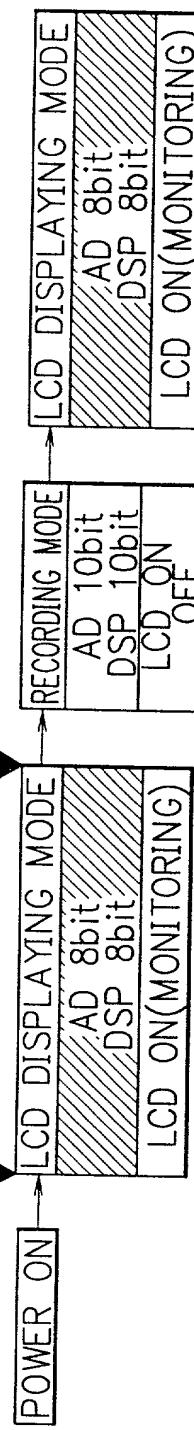
FIG. 6



F I G. 7A

TAKING IMAGE MODE

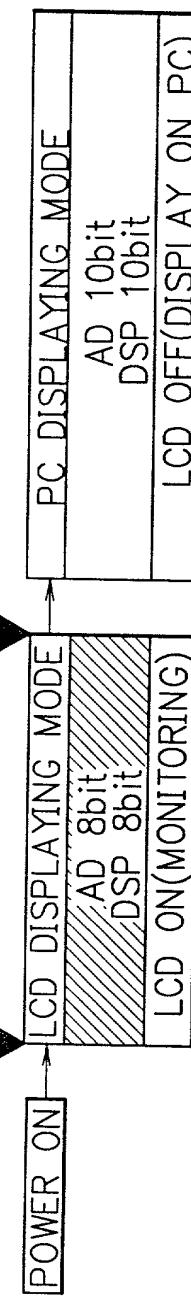
SHUTTER



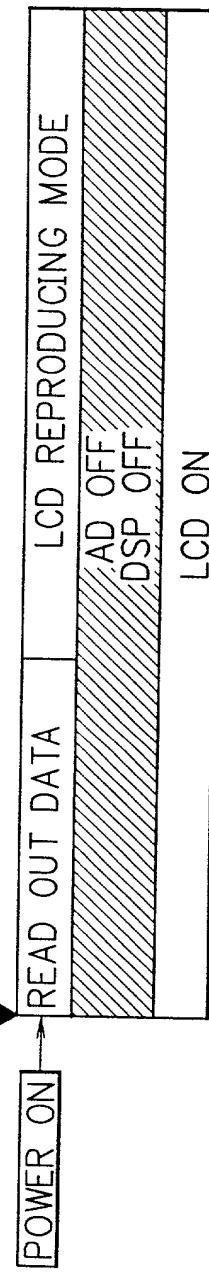
RECORDING COMPLETED

TAKING IMAGE MODE

PC DISPLAYING MODE

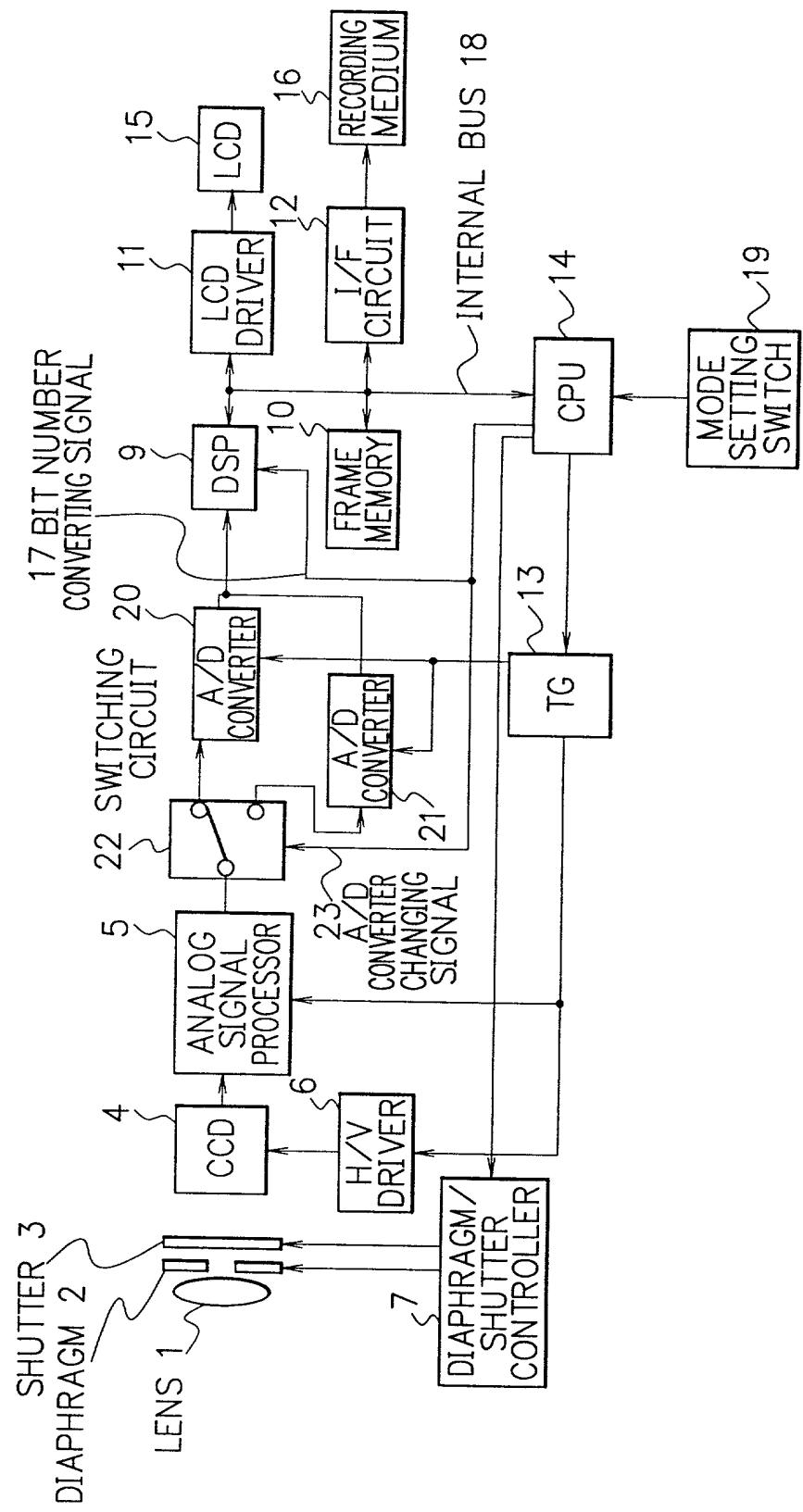


REPRODUCING MODE



F I G. 7C

FIG. 8



DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled IMAGE TAKING APPARATUS,

, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, S. 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, S.119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) on which priority is claimed:

<u>Prior Foreign Application(s)</u>			<u>Priority Claimed</u>
<u>319606/1999</u> (number)	<u>Japan</u> (country)	<u>10/11/1999</u> Day/Mo/Yr filed	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u> </u> (number)	<u> </u> (country)	<u> </u> Day/Mo/Yr filed	<input type="checkbox"/> Yes <input type="checkbox"/> No
<u> </u> (number)	<u> </u> (country)	<u> </u> Day/Mo/Yr filed	<input type="checkbox"/> Yes <input type="checkbox"/> No

And I hereby appoint HAYES, SOLOWAY, HENNESSEY, GROSSMAN & HAGE, P.C., a firm composed of Oliver W. Hayes, Reg. No. 15,867; Norman P. Soloway, Reg. No. 24,315; William O. Hennessy, Reg. No. 32,032; Susan H. Hage, Reg. No. 29,646; Steven J. Grossman, Reg. No. 35,001; and ~~Christopher K. Gagne, Reg. No. 36,142,~~ or any of them, of 175 Canal Street, Manchester, New Hampshire 03101 (Telephone: 603-668-1400) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith.

Please direct all future correspondence in connection with this application to the attention of Norman P. Soloway, Esq., HAYES, SOLOWAY, HENNESSY, GROSSMAN & HAGE, P.C., 175 Canal Street, Manchester, New Hampshire 03101 (Telephone: 603-668-1400).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole
or first inventor SATOSHI KATOH

First Inventor's
signature Satoshi Katoh (S) Date 10/31/2000

Residence Tokyo, Japan

Citizenship Japanese

Post Office Address c/o NEC Corporation, 7-1, Shiba 5-chome,
Minato-ku, Tokyo, Japan

Full name of second
joint inventor, if any _____

Second Inventor's
signature _____ Date _____

Residence _____

Citizenship _____

Post Office Address _____

Full name of third
joint inventor, if any _____

Third Inventor's
signature _____ Date _____

Residence _____

Citizenship _____

Post Office Address _____

Full name of fourth
joint inventor, if any _____

Fourth Inventor's
signature _____ Date _____

Residence _____

Citizenship _____

Post Office Address _____

Full name of fifth
joint inventor, if any _____

Fifth Inventor's
signature _____ Date _____

Residence _____

Citizenship _____

Post Office Address _____